Towards Smart Visualization for HPC Simulations

Lokman Rahmani, Gabriel Antoniu, Luc Bougé

Towards *Smart* Visualization for HPC Simulations

Lokman Rahmani[1,2], Supervisors: Gabriel Antoniu[3] & Luc Bougé[1,2]

[1]ENS Rennes, [2]IRISA Rennes, [3]INRIA Rennes, France

Doctoral Training Center Rennes

Context

- HPC platforms featuring **millions** of cores
- HPC scientific simulation on 100.000+ cores
- **Petabytes** of data to be post-processed and visualized
- Increasing **gap** between computational power and I/O capacity

Figure 1: Blue Waters NCSA supercomputer[1]

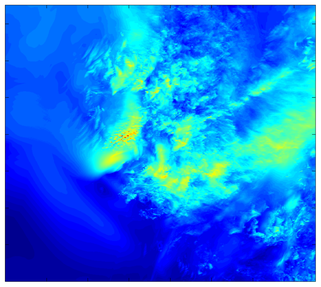


Figure 2: CM1 Tornado simulation

Acknowledgements

This work is done within the framework of the Joint Laboratory for Petascale Computing, an international collaboration between INRIA, the University of Illinois at Urbana-Champagn (IL. USA), and Argonne National Laboratory (IL. USA).

References

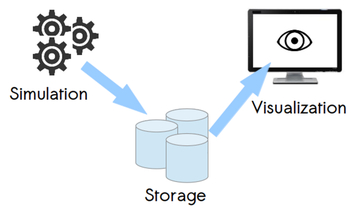
[1] http://www.ncsa.illinois.edu/BlueWaters/.

[2] Damaris/viz: http://damaris.gforge.inria.fr/.

[3] VisIt, https://wci.llnl.gov/codes/visit/.

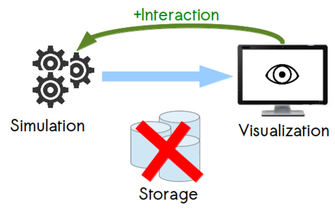
[4] Aladdin grid'5000: http://www.grid5000.fr.

Off-line Visualization



- I/O performances issues in the simulation
- I/O performances issues in the visualization tool
- Doesn't scale

In Situ Visualization



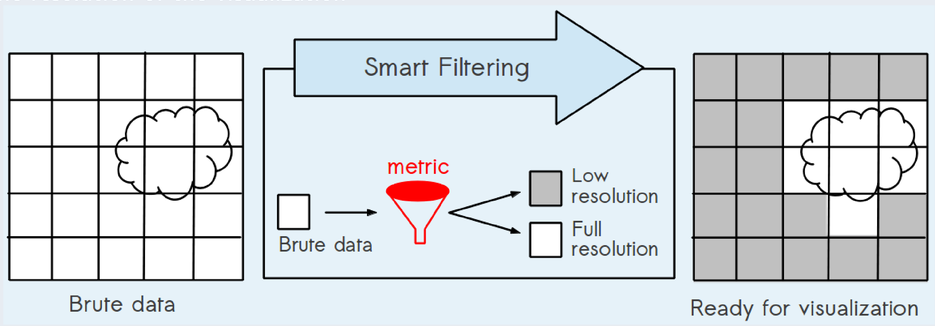
- Direct insight in the simulation
- Bypass the storage system
- Interactive

The Problem : Too much data generated by simulations!

Preparing data for visualization take too much time, which may **block** the simulation. This impacts badly the performances of the whole simulation process.

Our Idea: Smart ISV Framework Architecture

- Define a **semantics** of the data: variation in data
- **Automatically** detect interesting parts of data
- **Adapt** the resolution of the visualization



Implementation and Integration

Integration into existing ISV (Damaris/Viz[2]):

- **Without any code modification** in the simulation
- **No reconfiguration** of the visualization tool (VisIt[3]).

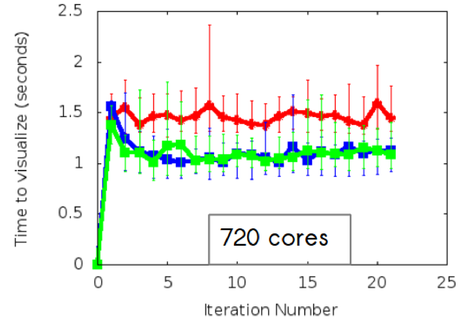
Automatically detect relevant data

Using different **metrics**, with respect to the defined *semantics*:

- Statistics: Coefficient of variation
- Information Theory: Entropy
- Image Processing: Gradient

Results: CM1 application, Grid5000[4] testbed

Impact of Smart ISV: Local Rendering



Impact of Smart ISV: Scalable Rendering

Conclusion

1. Defined data semantics: more **variation** in the data implies interesting data
2. **Automatically detect** the relevant parts of the data with respect to the defined semantics.
3. Visualizing **only** the relevant parts of the generated data provides up to **40% gain** in visualization time without quality loss.